Tiscia (Szeged) Vol. XI, pp. 11—16 (1976)

FACTORS, NATURAL FUNDAMENTALS, AND ARTIFICIAL EFFECTS DETERMINING THE HYDROECOLOGICAL STATE OF THE RIVER TISZA

P. VÉGVÁRI

Hydrokidopid Laboratory of Kisköre Reservoir, Kisköre, Hungary
(Received 30 June, 1975)

Abstract

The paper is dealing with natural fundamentals and artificial interventions that are necessary to evaluate the hydrochemical and hydrobiological investigations carried out in the Tisza

Introduction

The hydroecological state of the Tisza water is a function of a great many factors.

At evaluating the results of investigations, we have to take into consideration the formation of the most important factors influencing the chemical composition of, and biological changes in the Tisza, among these the effects of natural fundamentals and artificial interventions.

The geological development of the Tisza was treated of by RÓNAI (1966), the properties of its watershed area by BOGDÁNFFY (1924), ANDÓ (1969), the conditions of its water output, water level, and alluvial deposit by KORBÉLY (1937), LÁSZLÓFFY—BÖHM (1932), MEZŐSI—DONÁTH (1952), and ANDÓ—VÁGÁS (1974), in the fullest detail.

The "limnophysiographic" characterization of the Tisza and its affluents were summed up by UHERKOVICH (1971), on its chemical composition we were informed by the annual publication of "VIKÖZ", entitled: "Alapadatok a vízminőséggazdálkodáshoz" (Fundamentals to the water-quality economy).

Apart from the natural fundamentals of the Tisza, in our days we have to take into account also the effects of some artificial interventions like damming, storing, urbanization, industrial and agricultural activities, as well as the extraordinary pollutions.

Natural fundamentals

The Tisza may be included among the young rivers in geological sense, having the age of hardly a few ten thousand years.

The emergence of the Nyírség (a district in North-Eastern Hungary) diverted the rivers of the Northern Great Plain in western direction, compelling them to join, and the movements of the earth that had played a part in forming the present-day Danube—Tisza Interstream Region, drove the Danube to the edge of the Transdanubian platform.

The broad basin between the two hilly countries rising above the surroundings in this way was taken up by a new river, the Tisza. That was from the beginning a main river, joining almost all the waters of the Great Plain.

The watershed area of the Tisza, in a narrow sense, — about 13,173 sq.km — extends till the mouth of the Szamos. It is mostly a mountainous and hilly country. From there, the Tisza is, in fact, a recipient of the single tributaries. The shape of the watershed area is unfavourable, short and broad. The slope of mountain- and hill-sides is very steep, the tributaries reach the main river after a comparatively short course, the waves of floods accumulate. The rainiest part is the territory of the Carpathian Ukraine where the May and June showers and October rains are frequent. The fall of the main basin is from the river-head till the mouth of the Szamos 584 cm/km on the average; that in the Hungarian stretch is, however, extremely small, between 10 and 1 cm/km. At floods, the fall of water suddenly grows in the front of the flood-passing, manifested very strongly in the increased speed of flowing (Fig. 1).

From the watershed area of the Upper-Tisza waters of violent water-course rush down, being able to sudden inundations, and reaching the flatland that is nearly without any fall, they accumulate. The show in the mountains thaws at the feet of mountains at the end of March and in April, and on the hills already in the first part of April. From that part of the watershed area of the Tisza generally three major flood-waves start:

— the late-winter and spring floods originating from the thaw of the snow-cover of the flatland and hill-country (late February, March);
— the spring-flood resulting from the thaw of the snow-cover of mountains (April, May) and mainly from the showers of the territory of the Carpathian Ukraine (May, June);
— the autumn- or leaf-covered flood resulting from the summer and autumn rainfalls and corresponding to precipitation maxima that come mostly not in a striking way.

From the middle of Summer till the middle of Autumn a typical "small-water period" develops. The Tisza is, in most part of its course and according to its general character, a flatland river. Its water output and water movement are, however, determined first of all by the peripheral mountains, and the extent of the specific water transport by the precipitation that fell from Autumn till Spring and accumulated in the shape of snow.

The Upper-Tisza and its tributaries filled up the valleys with stone, river-gravels, the gravel-ground of the river-bed being 5 to 10 m thick or even a thicker layer. Below Tiszabecs the gravel is replaced by coarse-grained sand, then the river-bed becomes increasingly siltier till the mouth of the Szamos. The Szamos again carries coarse-grained sand into the bed of the Tisza, forming deposits in form of sandbanks between Vásárosnamény and Tiszakecel.

The medium speeds of the bed can be put at 0.4 m/sec, that of the current at 0.6 m/sec. In case of large water at Tiszabecs the speed of the current attains 4 m/sec and, similarly in case of large water, at Vásárosnamény the speed of flow can be esteemed 2.5 m/sec.

The quality of Tisza-water in the segment of the national boundary (river-km 757) is very favourable. It is characterized by a low oxygen consumption, and the low value of mineral-matter content and ammonium. The quantity of direct pollution of water-course till Szolnok is not considerable, only the affluents do exert a loading effect.

At floods the suspended matter content is very high. It is characteristic of its alluvial transport that it can drift at Máramarossziget still large blocks of stone, at Bökény stones as big as a fist and head. Below Mezővár it already drops even a pebble, its sand, too, becomes finer and finer, and at Vásárosnamény its alluvium is already mostly fine silt. Its dominant water type contains calcium-hydrogen-carbonate. The quantity of the Tisza water is influenced by the water-composition of its major tributaries, as well, mainly in the period of floods.

The major tributaries of the Upper-Tisza are the Szamos, Bodrog, and Sajó rivers.

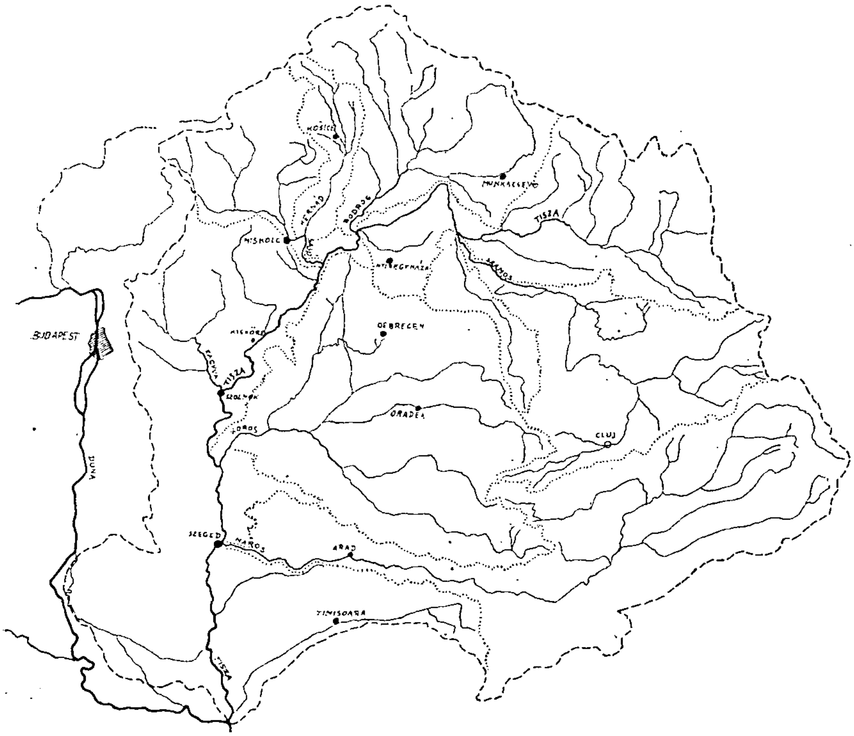

Fig. 1. Map of the Tisza and its tributaries

The watershed area of the Szamos is 15,882 sq.km, mostly medium and low mountains, in a smaller part a flat region. The formation of sudden floods is promoted by its impermeable rocks. Summer showers are frequent, larger autumn rains occur but rarer.

The dominant type of Szamos-water at small water output contains calcium-sodium hydrogencarbonate, at large water output calcium-magnesium hydrogen-carbonate. Its suspended matter content is high mainly at the time of a flood.

The watershed area of the Bodrog is 13,579 sq.km. it is lying in a region with not too high mountains, its shape is unfavourable. Because of the semipermeable surface and the rich enough precipitation, the river carries a considerable water mass into the Tisza.

In a fan-like valley-system the waters gushing down with high speed from the mountains accumulate in the flatland as the fall is only 3 cm/km there. Its rain-induced flood-waves get to the mouth 3—4 days later, as compared to the flood-waves of similar origin in the Tisza. The water of the Bodrog may be characterized with its small oxygen content. It is polluted according to the indices of the oxygen household, as well as on the basis of the quantity of ammonium. Its suspended matter content, is but a little higher if the water output increased. Its dominant water type contains at small water calcium-magnesium hydrogencarbonate, at medium and large water calcium hydrogencarbonate.

The common watershed area of the Sajó and Hernád is 12,708 sq.km, it is fan-like, keeping its mountainous character as far as the mouth of these river. Its fall is great: 44 cm/km even in its lowest region. The flood-waves get, therefore, ahead of those in the Tisza 4—5 days.

From its valleys of loose soil the flooding water carries with itself much alluvium. The total hardness and total dissolved matter content of these waters increase along the water-course. Their suspended matter content is very high at flood but it is low at small water. Their dominant water-type contains at small and medium water outputs calcium-magnesium hydrogencarbonate-sulphate, at large water calcium hydrogencarbonate.

Artificial effects

Damming

The regulation of the changeable water movements of the natural water-courses, the utilization of the available supply of water as properly as possible, the formation of a satisfactory water-way can be assured by means of building river barrages.

The artificial formation of a comparatively lasting water-level, the damming, influences both the chemical composition and the biological conditions of the Tisza considerably. As a result of that, the water mass of the stretch dammed inreases, the speed of water-course decreases. It plays an essential part in forming the conditions of suspended matter, increasing the transparency of water, and shifting the percentages of the equivalents of chemical components, *i. e.*, in changing the water-type.

To damming, the living beings do respond sensitively, as well. In its plankton some micro-organisms multiplied that had occurred but rarely so far or had even been unknown.

In the small-water period that is so characteristic of the Tisza, as a result of damming the backwater character becomes manifest both in chemical and biological relations (Ádámosi *et al.* 1974, Hamar 1975, Végvári 1975).

Storing

Storing can be placed among the artificial interventions having an influence on water quality, putting forward some effects that were insignificant for the freshwater. The formation of the chemical composition and biological state of the water stored depends in high degree upon the water-depth of the reservoir, the organic-matter loading, therefore upon the quantity of the land vegetation that remained in the storing space, upon the organic-matter and mineral-matter content of the surface soil, as well as upon the floating matter carried by the supplying river. It depends, overmore, upon the size of the water surface, the temperature, the evaporation and concentration induced by these.

The living beings of water can be determined to a great extent by the rich micro- and macroflora, as well as the fauna of the dead arms and borrowing-pits in the bed of the reservoir to be formed.

There appear, as new factors, the effect of the wind and the size of waves brought about by that, as well, that can exert an influence, apart from inundations and the living beings in water, on the formation of the suspended matter content and the oxygen circulation, too.

Urbanization, industrial and agricultural activity

The water-quality is also considerably influenced by the waste-waters, induced by the communal, industrial, and agricultural activities, carried without cleaning or after an inadequate purification into the living freshwater, as well as by the matters getting into the water or applied without due foresight. The waste-waters of organic-matter content (faeces, industrial refuse from sugar-works, paper-mills, etc.) may cause directly a rise in the saprobity degree of water, indirectly in the trophity degree of it; the waste-waters including chemical fertilizers may cause directly a rise in the trophity degree of water, indirectly in the saprobity degree of it; and the waste-waters containing poisoning materials (heavy-metal salts, cyanides, pesticides, etc.) may cause a rise in the toxicity degree of water.

A considerable mass of cooling water of higher temperature, removed from the freshwater and getting back there after being emolliated, results in heat-pollution and in changing the quantitative conditions of the salt content.

Extraordinary pollutions

It has been proved by the experiences of the last years both in this country and abroad, how great dangers can be induced by some extraordinary pollutions originating from traffic and water-way accidents, operating troubles, failures of cables crossing a freshwater, that passing down the water-course as waste-water waves, are changing its chemical composition, damaging its natural history (HAMAR 1970/71). The effects of the waste-water waves may bring about temporary changes in a freshwater (UHERKOVICH 1971) but the changes induced by them in the reservoir are considerably more dangerous and enduring.

A forecast of the hydroecological changes in the future reservoirs can only be achieved by recognizing the regularities of nature, and evaluating the artificial fish-ponds in an up-to-date way, supporting that with the results of investigations.

The more and more increasing water demand of the society can be satisfied in both quantitative and qualitative relations by taking advantage of the natural opportunity and revealing the causes of the unfavourable effects and bringing them to an end.

References

ANDÓ, M. (1969): Climatic and microclimatic peculiarities of the Tisza and its inundation area. — Tiscia (Szeged) *5*, 15—36.

ANDÓ, M. and VÁGÁS, I. (1973): The great flood in the Tisza basin in 1970. Tiscia (Szeged) *6*, 9—32.

ÁDÁMOSI, M. *et al.* (1974): Duzzasztás hatása a Tisza vízminőségére a Kiskörei Vízlépcső térségében (Influence of damming upon the water-quality of the Tisza in the area of the Kisköre River Barrage). — Hidrol. Közl. *12*, 570—576.

BOGDÁNFFY, Ö. (1924): Az Alföld hidrológiája (Hydrology of the Great Hungarian Plain). — Debrecen.

HAMAR, J. (1970—1971): Effect of the waste-water of sugar-works on natural history of the river Zagyva. — Tiscia (Szeged) *6*, 109—28.

HAMAR, J. (1975): Data to the bacteriological and algological conditions of the region of Kisköre River Barrage Tiscia (Szeged) *11*.

KORBÉLY, I. (1937): A Tisza szabályozása (The Tisza control). — Debrecen.

LÁSZLÓFFY—BÖHM, W. (1932): A Tiszavölgy (The Tisza basin). Vízügyi Közl. *14*, 108—142.

MEZŐSI, I.—É. DONÁTH (1952): Investigation of the dissolved and floating material of the Tisza and Maros. — Acta Min. Pet. (Szeged) *6*, 36—41.

PAPP, SZ. (1965): Felszíni vizeink minősége (Quality of our surface waters). — Hidrol. Közl. *45*, 30—36.

RÓNAI, A. (1966): A Tisza geológiája (Geology of the Tisza). — Jászkunság *12*, 145—151.

UHERKOVICH, G. (1971): A Tisza lebegő paránynövényei (A Tisza fitoszesztonja). [The floating microplants of the Tisza (Phytoseston of the Tisza)]. — Szolnok.